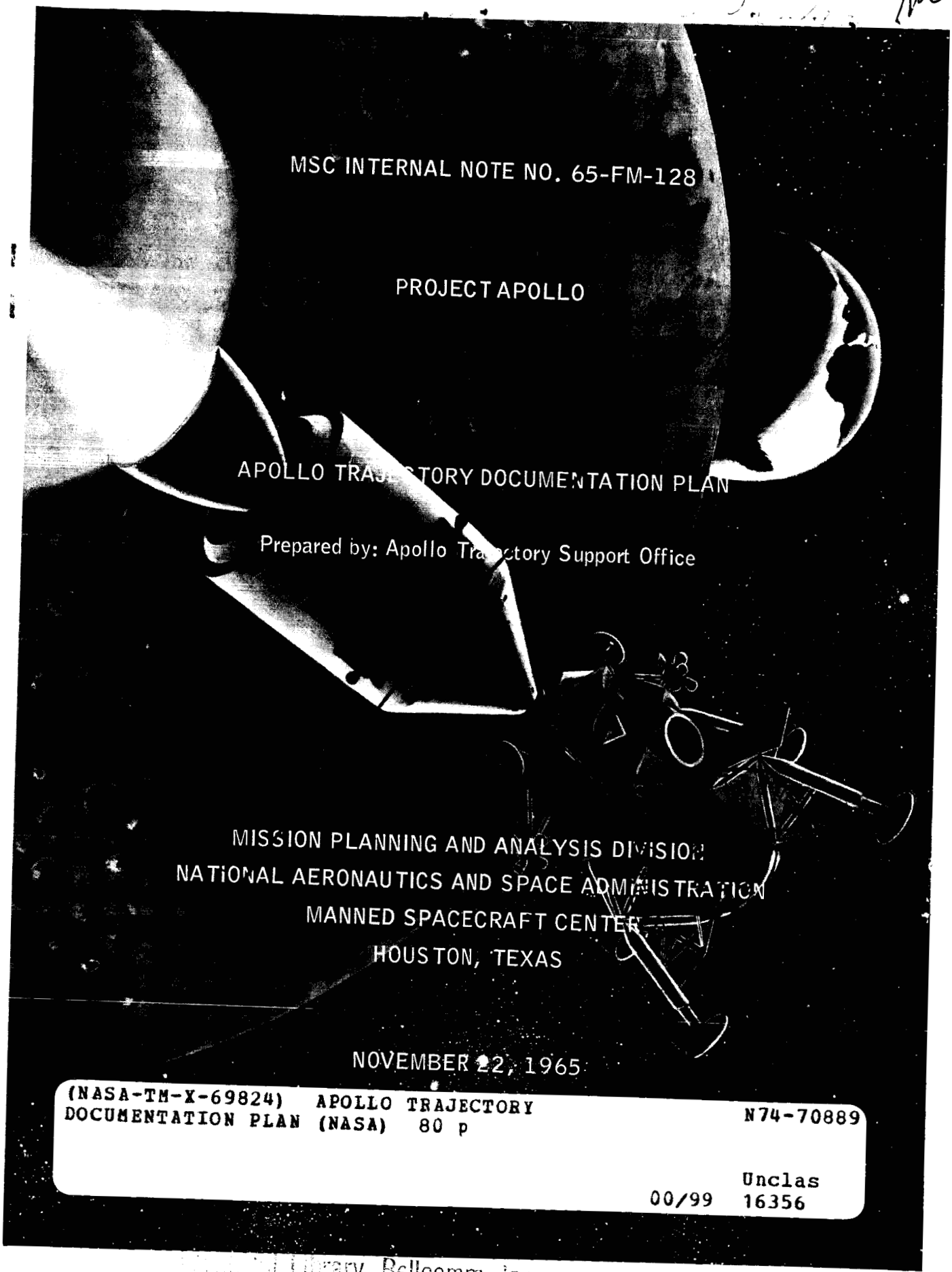

MSC INTERNAL NOTE NO. 65-FM-128

PROJECT APOLLO

APOLLO TRAJECTORY DOCUMENTATION PLAN

Prepared by: Apollo Trajectory Support Office

MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

NOVEMBER 22, 1965

MSC INTERNAL NOTE NO. 65-FM-128

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APOLLO TRAJECTORY DOCUMENTATION PLAN

Prepared by: Apollo Trajectory Support Office

November 22, 1965

MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

Approved: John P. Bryant
John P. Bryant, Head
Apollo Trajectory Support Office

Approved: John P. Mayer
John P. Mayer, Chief
Mission Planning and Analysis Division

SUMMARY

An Apollo Mission Trajectory Documentation Plan has been prepared to define the principal documents covering information flow in the areas of mission planning and trajectory design. In addition, a set of detailed information flow charts and a current schedule have been included to illustrate the variety of interfaces covered by the documentation and to provide insight into the relationship between each phase of mission development and the rest of the Apollo Program.

INTRODUCTION

It is the purpose of this note to provide a listing, a detailed definition, and a current schedule of all documentation directly associated with Apollo mission design and trajectory analysis. The documentation plan, as presented, represents an agreed to and working procedure between MSC and MSFC mission design groups. Furthermore, the interfaces between MSC and all three principal contractors have been defined and their participation in the mission design process noted.

The amount of documentation herein defined may at first appearance seem overly complex. The intention of this collection, however, is to be as complete as possible so that a meaningful and encompassing schedule may be developed. As a result, a variety of documents, not normally considered trajectory oriented, are included which either interface directly or are indirectly dependent upon key trajectory milestones. The basic assumption employed in the development of the structure and schedule of this plan was that the original arrangement of the mission development milestones, which were tied to the spacecraft computer software and MCC-H real-time computer software schedules, were reasonable unless otherwise challenged. Any disagreements which arose were negotiated; this present schedule and documentation structure, to the best of our knowledge, represents an agreeable plan to all parties concerned.

The funtional flow diagrams break the mission development down to essentially three phases. The documentation points or major milestones are designed to define and implement these phases. The three phases are:

- Mission Definition
- Mission Design
- Flight Preparation

Implicit in the construction of this plan is the assumption that "Mission Design" is completed with the issuance of the "Reference Trajectory". Any trajectory work done after this point in time is done primarily to

provide the necessary details for the actual flight. The completion of the mission design phase has been scheduled to coincide with the initiation of programming for the onboard guidance computers.

Where possible, the responsibility for each NASA mission development document has been assigned at the branch level. In general, this organization will perform the majority of the work associated with that particular piece of information and in any case, has the responsibility for editing and publishing it. In the case of joint MSC-MSFC documents, they will be handled through the Flight Mechanics Panel or one of its subpanels.

At the present time, the only trajectory document which will be issued in both English and metric units is the reference trajectory for the lunar missions. This has been agreed to between MSC and MSFC in the Reference Trajectory Subpanel of the Flight Mechanics Panel. It is expected that parts of all documents issued jointly by MSC and MSFC will be published in both metric and English units. In general, it is planned that mission phases which are of direct interest to MSFC will be published in both English and metric form. MSFC will, in turn, provide English unit printouts for the booster and earth orbital parts of the mission. The exact breakdown of what part of each document will appear in this dual fashion must be determined by negotiation with MSFC in the Flight Mechanics Panel.

APOLLO MISSION

TRAJECTORY DOCUMENTATION PLAN

SEPTEMBER 1, 1965

CONTENTS

TABLE I - APOLLO TRAJECTORY DOCUMENTATION SCHEDULE

		DOCUMENT TITLE	RESPONSIBILITY	SATURN - APOLLO SCHEDULE 201	202	204/5	206	207	501	502	503	504	505	506	507
1		Test Requirements	NAA/GAEC												
2		[illegible] Mission Requirement	ASPO												
3		L/V Mission Requirement	MSFC												
4	M3	Mission Requirements and Constraints	ASPO	-	-	-	-	-	-	-	-	11/1/65	[illegible]	5/1/66	8/1/66
5		Apollo Mission Data Specification A	ASPO	-	-	-	-	-	-	-	-	[illegible]	[illegible]/66	5/1/66	[illegible]
6		Performance [illegible] (Lunar Missions)	MPAD	-	-	-	-	N/A	N/A	N/A	[illegible]	[illegible]	[illegible]/66	6/1/66	[illegible]
7	M5	MSFC Preliminary Mission Profile	MSFC	-	-	-	-	-	-	-	-	[illegible]/66	4/1/66	7/1/66	[illegible]
8	M4	MSC Preliminary Mission Profile	MPAD	-	-	-	-	-	-	-	11/1/65	[illegible]	[illegible]	7/1/66	[illegible]
9		Apollo Mission Data Specification B	ASPO	-	-	-	-	[illegible]/1/65	-	-	[illegible]/1/65	[illegible]	5/1/66	8/1/66	11/1/66
10	M6	Preliminary L/V Reference Trajectory	MSFC	-	-	-	-	10/1/65	-	-	12/1/65	[illegible]	6/1/66	[illegible]	12/1/66
11	M7	Preliminary S/C Reference Trajectory	MPAD	-	-	-	-	11/1/65	-	10/1/65	[illegible]	[illegible]	7/1/66	[illegible]	[illegible]
12	M8	Preliminary Reference Trajectory	MPAD/MSFC	-	-	-	-	[illegible]	-	11/1/65	[illegible]	[illegible]	8/1/66	11/1/66	2/1/67
13	M9	Oper. Requirements for S/C Nav., Guid.&Cont.	MPAD	-	-	-	Comp.	1/1/66	-	[illegible]/65	[illegible]	[illegible]	[illegible]/66	12/1/66	[illegible]
14	M[illegible]	L/V Targeting Proposal	MPAD	-	-	-	Comp.	1/1/66	-	[illegible]	[illegible]/1/66	[illegible]	[illegible]	[illegible]	[illegible]
15	M[illegible]	L/V Targeting Proposal	MSFC	-	-	-	Comp.	1/1/66	-	10/1/65	[illegible]/1/66	4/1/66	7/1/66	[illegible]	[illegible]
16	M[illegible]	L/V Targeting Requirements	MPAD/MSFC	-	-	-	Comp.	[illegible]/1/66	-	11/1/65	[illegible]/1/66	[illegible]/1/66	9/1/66	[illegible]	[illegible]
17	M[illegible]	L/V Guidance Equations	MSFC	-	-	Comp.	Comp.	Comp.	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	M[illegible]	S/C G&N Systems Operations Plan	G&CD	-	-	-	11/15/65	[illegible]	-	[illegible]/1/65	[illegible]/1/66	[illegible]	11/1/66	[illegible]/1/67	[illegible]
19		Preliminary MSFN Error Analysis	MPAD	-	-	7/15/65	-	1/66	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20		[illegible] Coverage Evaluation	[illegible]	-	-	[illegible]	[illegible]	[illegible]/66	[illegible]/1/65	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21		Apollo Mission Data Specification C	ASPO	-	-	-	[illegible]	/1/66	-	[illegible]/1/65	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22		Vehicle Detailed Test Plan	NAA/GAEC	-	-	10/8/65	Comp.	[illegible]/1/65	[illegible]	11/1/65	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23		Mission Directive	ASPO	-	-	11/9/65	10/8/65	[illegible]	10/8/65	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24		Prel. Abort & Alt. Missions Studies - MSC	MPAD	-	-	-	-	[illegible]/1/66	-	[illegible]/1/65	[illegible]/1/66	[illegible]	[illegible]	[illegible]	[illegible]
25		Flight Operations Plan	[illegible]	-	-	[illegible]	[illegible]	[illegible]/1/66	[illegible]	[illegible]/66	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
26		Preliminary Dispersion Analysis	MPAD	-	-	10/1/65	[illegible]/1/66	[illegible]	[illegible]/66	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27	M17	MSC Mission Constraints	MSC/MSFC	-	-	-	11/1/65	[illegible]/1/66	10/1/65	1/1/66	[illegible]/1/66	[illegible]	[illegible]/67	[illegible]/1/67	[illegible]
28	M[illegible]	L/V Preliminary Error Anal. (closed loop)	MSFC	-	-	-	11/1/65	[illegible]/1/66	[illegible]	[illegible]/66	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29	M[illegible]	MSFC Mission Constraints	MSFC	-	-	Comp.	Comp.	[illegible]	[illegible]	1/1/66	[illegible]	[illegible]	1/1/67	[illegible]	[illegible]
30	M[illegible]	Reference Mission Constraints	ASPO/MSFC	-	-	[illegible]/1/65	11/1/65	[illegible]/1/66	[illegible]/1/65	1/1/66	[illegible]/1/66	[illegible]	[illegible]	[illegible]	[illegible]
31		[illegible] Mission Systems Compatibility	NAA/GAEC	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]/66	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32	M[illegible]	L/V Reference Trajectory	MSFC	-	-	[illegible]	[illegible]	[illegible]/1/66	[illegible]	[illegible]/66	7/1/66	[illegible]	[illegible]	[illegible]	[illegible]
33	M[illegible]	S/C Reference Trajectory	MPAD	-	-	-	[illegible]/1/66	6/1/66	-	[illegible]/1/66	[illegible]	[illegible]	[illegible]/1/67	[illegible]	[illegible]
34	M[illegible]	Reference Trajectory	MPAD/MSFC	-	-	[illegible]	[illegible]/66	7/1/66	11/15/65	[illegible]/66	[illegible]	[illegible]/67	[illegible]	[illegible]	[illegible]
35	M[illegible]	Prel. Abort & Alt. Missions Studies MSFC	MSFC	-	-	[illegible]	[illegible]	[illegible]/1/66	[illegible]	[illegible]/66	[illegible]/1/66	7/1/66	[illegible]/1/66	[illegible]	[illegible]
36		Real Time Program Requirements ([illegible])	MPAD	-	-	[illegible]/1/65	[illegible]	[illegible]/1/66	[illegible]/65	10/1/65	1/1/66	6/1/66	[illegible]/1/66	[illegible]	[illegible]/67

TABLE I - APOLLO TRAJECTORY DOCUMENTATION SCHEDULE

		DOCUMENT TITLE	RESPONSIBILITY	SATURN - APOLLO SCHEDULE											
				201	202	204/5	206	207	501	502	503	504	505	506	507
37		Preliminary Operational Timeline	NAA/GAEC	-	-	-	11/1/65	4/1/66	10/15/65	1/1/66	7/1/66	10/1/66	1/1/67	4/1/67	7/1/67
38		Apollo Mission Data Specification D	ASPO	-	-	4/1/66	10/1/66	1/1/67	7/1/66	11/1/66	3/1/67	8/1/67	11/1/67	2/1/68	5/1/68
39		S/C G & N Systems Operation Plan, Rev. 1	G&CD/MIT	-	-	12/1/65	4/1/66	7/1/66	2/1/66	5/1/66	10/1/66	2/1/67	5/1/67	9/1/67	11/1/67
40		S/C Oper. Guid. Computer Program Verif. Rqmts.	MPAD/G&CD	-	-	1/1/66	6/1/66	9/1/66	5/1/66	6/1/66	11/1/66	2/1/67	5/1/67	8/1/67	11/1/67
41	M23	L/V Guidance Error Analysis	MSFC	-	-	2/1/66	3/1/66	6/1/66	12/1/65	4/1/66	9/1/66	12/1/66	3/1/67	6/1/67	9/1/67
42	M24	L/V Performance Analysis	MSFC	-	-	2/1/66	3/1/66	6/1/66	12/1/65	4/1/66	9/1/66	12/1/66	3/1/67	6/1/67	9/1/67
43	M25	Guidance Computer Flt Prog Verif.	G&CD/MIT	-	10/1/65	4/1/66	10/1/66	1/1/67	7/1/66	11/1/66	4/1/67	8/1/67	11/1/67	2/1/68	5/1/68
44	M26	MSFN Error Analysis	MPAD	-	-	3/1/66	6/1/66	9/1/66	4/1/66	7/1/66	11/1/66	5/1/67	8/1/67	11/1/67	2/1/68
45	M27	S/C Dispersion Analysis	MPAD	7/1/65	8/1/65	3/1/66	6/1/66	9/1/66	4/1/66	7/1/66	11/1/66	5/1/67	8/1/67	11/1/67	2/1/68
46		Initial RTCC Operations Support Plan	MPAD	-	11/1/65	3/11/66	8/1/66	11/1/66	8/3/66	8/1/66	11/1/66	2/1/67	5/15/67	8/15/67	11/15/67
47		Apollo Operational Timeline	NAA/GAEC	N/A	-	1/18/66	7/1/66	10/1/66	3/15/66	8/1/66	1/1/67	5/1/67	8/1/67	11/1/67	1/1/68
48		Preliminary Mission Flight Plan	FCSD	N/A	-	4/1/66	10/1/66	1/1/67	7/1/66	11/1/66	3/1/67	8/1/67	11/1/67	2/1/68	5/1/68
49	M28	Operational Mission Constraints	ASPO/MSFC	-	10/1/65	4/1/66	10/1/66	1/1/67	7/1/66	11/1/66	4/1/67	10/1/67	1/1/68	4/1/68	7/1/68
50	M31	Operational L/V Flight Trajectory	MSFC	-	11/1/65	5/1/66	11/1/66	2/1/67	8/1/66	12/1/66	4/1/67	10/1/67	1/1/68	4/1/68	7/1/68
51	M29	L/V Range Safety Trajectory Plan	MSFC	-	2/1/66	8/1/66	12/1/66	3/1/67	10/1/66	2/1/67	6/1/67	10/1/67	1/1/68	4/1/68	7/1/68
52	M33	L/V Alternate Mission and Abort Trajectory	MSFC	10/1/65	1/1/66	7/1/66	12/1/66	3/1/67	9/1/66	1/1/67	5/1/67	11/1/67	2/1/68	5/1/68	8/1/68
53	M32	Operational S/C Flight Trajectory	MPAD	11/1/65	12/1/65	6/1/66	12/1/66	3/1/67	9/1/66	2/1/67	5/1/67	11/1/67	2/1/68	5/1/68	8/1/68
54	M30	S/C Range Safety Trajectory Plan	MPAD	11/1/65	2/1/66	8/1/66	1/1/67	4/1/67	10/1/66	2/1/67	6/1/67	11/1/67	2/1/68	5/1/68	8/1/68
55	M34	S/C Alt. Mission & Abort Trajectory	MPAD	10/1/65	1/1/66	7/1/66	12/1/66	3/1/67	9/1/66	1/1/67	5/1/67	11/1/67	2/1/68	5/1/68	8/1/68
56		S/C Orbital Debris	MPAD	11/1/65	2/1/66	7/1/66	1/1/67	4/1/67	10/1/66	2/1/67	6/1/67	11/1/67	2/1/68	5/1/68	8/1/68
57		Programmer Working Book	MPAD	11/1/65	2/1/66	7/1/66	1/1/67	4/1/67	10/1/66	2/1/67	6/1/67	11/1/67	2/1/68	5/1/68	8/1/68
58		L/V & S/C Guid. Compatibility Verification	MPAD/MSFC	N/A	N/A	N/A	N/A	4/1/67	N/A	N/A	5/1/67	11/1/67	2/1/68	5/1/68	8/1/68
59		RTCC Operations Support Plan	MPAD	-	2/1/66	8/1/66	2/1/67	5/1/67	11/1/66	2/1/67	5/1/67	12/1/67	3/1/68	6/1/68	9/1/68
60		Mission Flight Plan	FCSD	-	12/1/65	7/1/66	1/1/67	4/1/67	10/1/66	2/1/67	6/1/67	11/1/67	2/1/68	5/1/68	8/1/68
61		Postflight Trajectory Analysis	MPAD	-	-	-	-	-	-	-	-	-	-	-	-

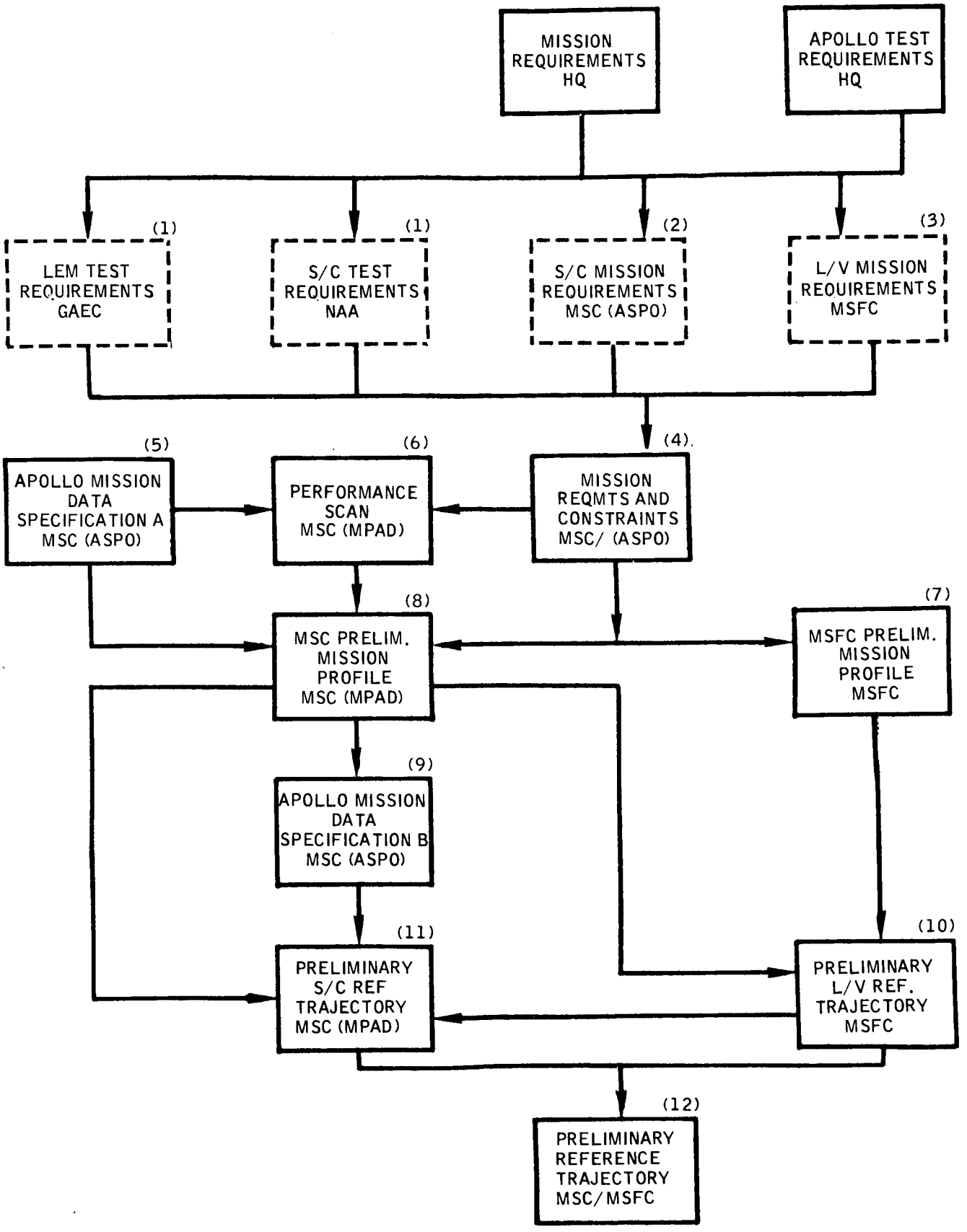


Figure 1. - Phase I - Apollo mission trajectory documentation flow plan.

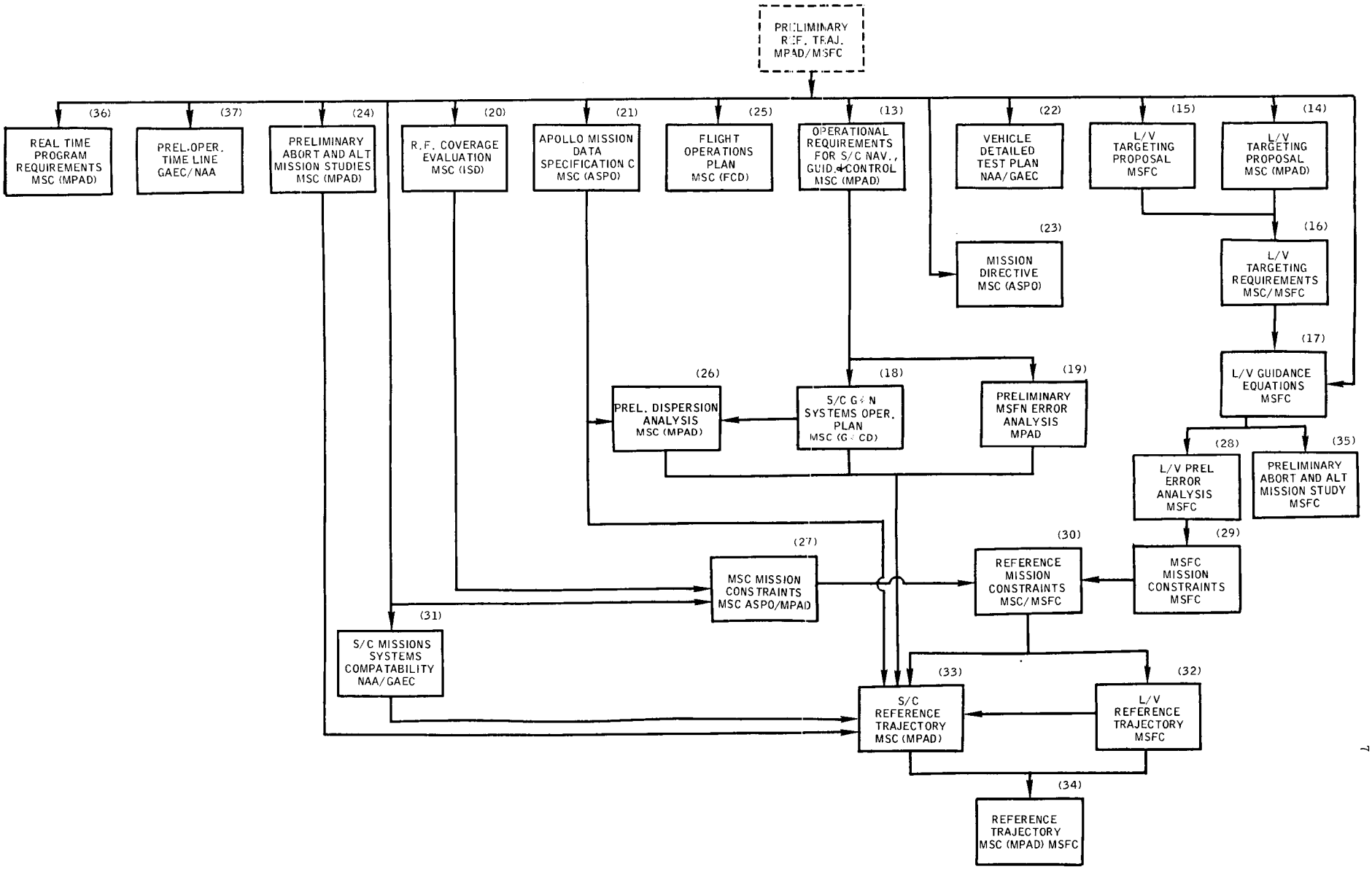


Figure 2. - Phase II - Mission design.

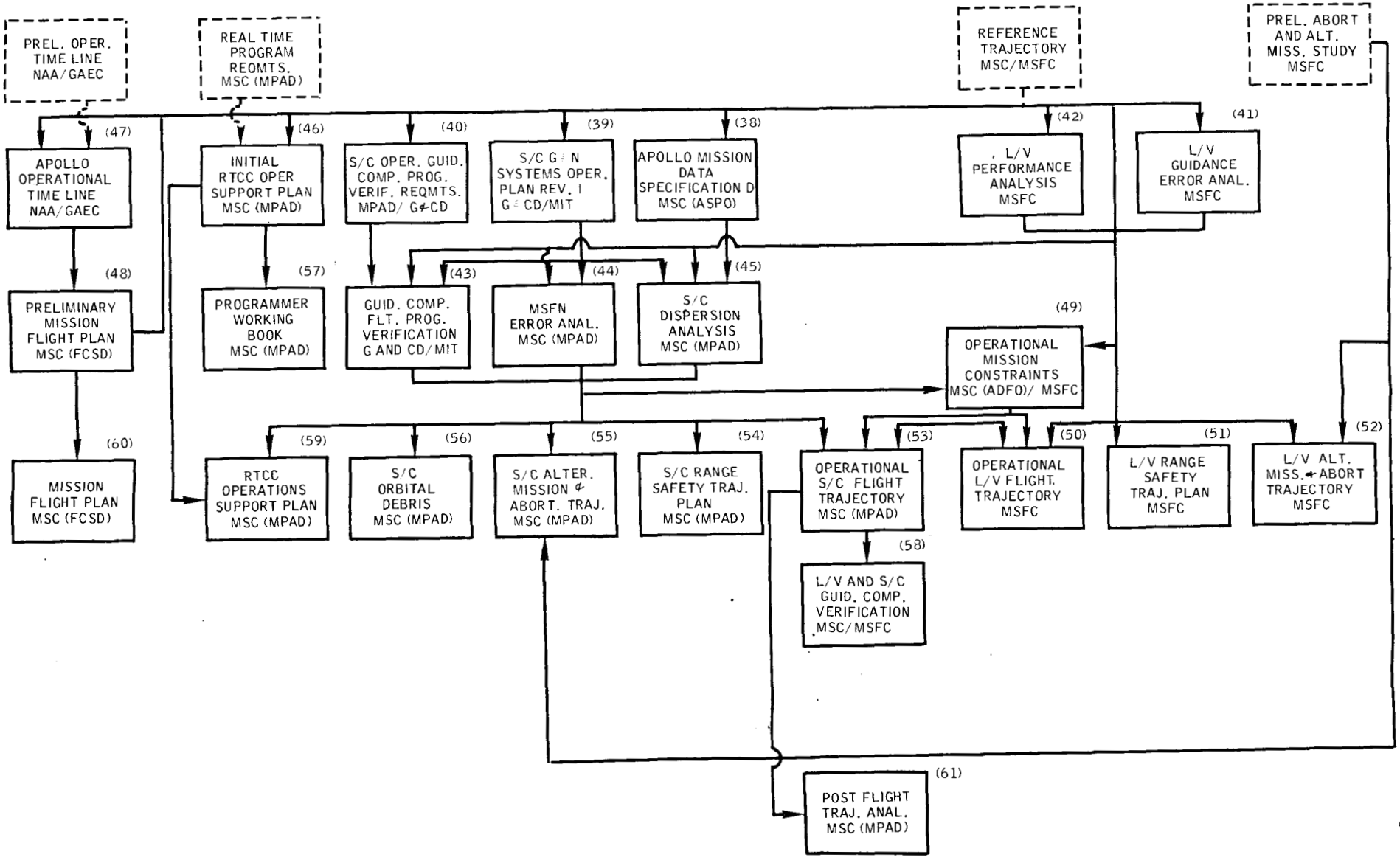
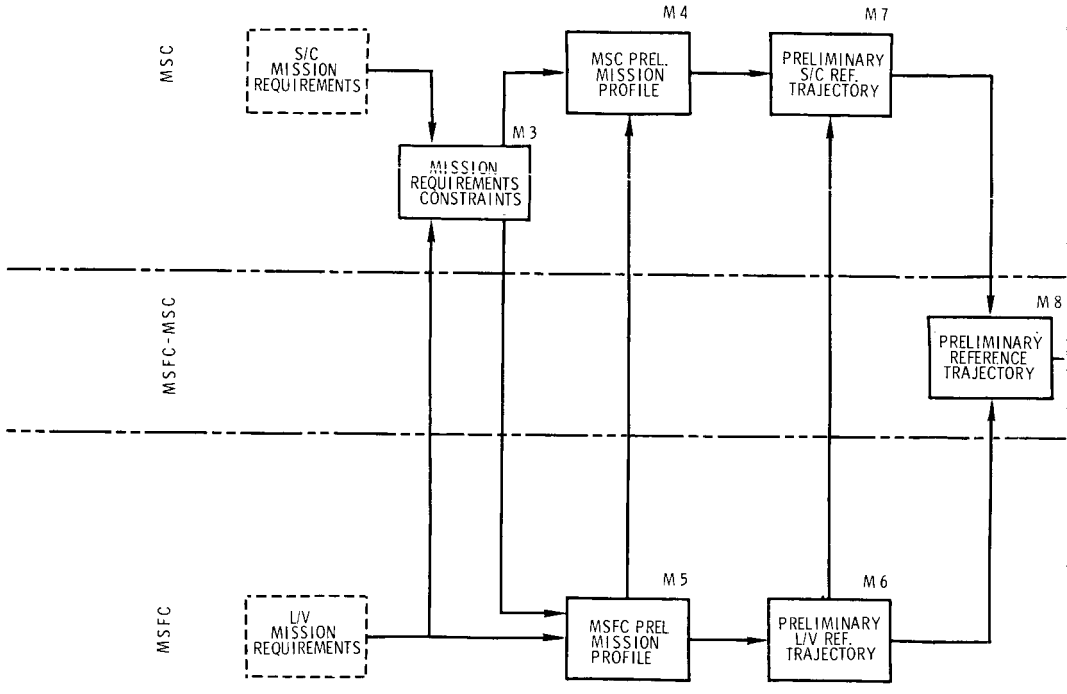
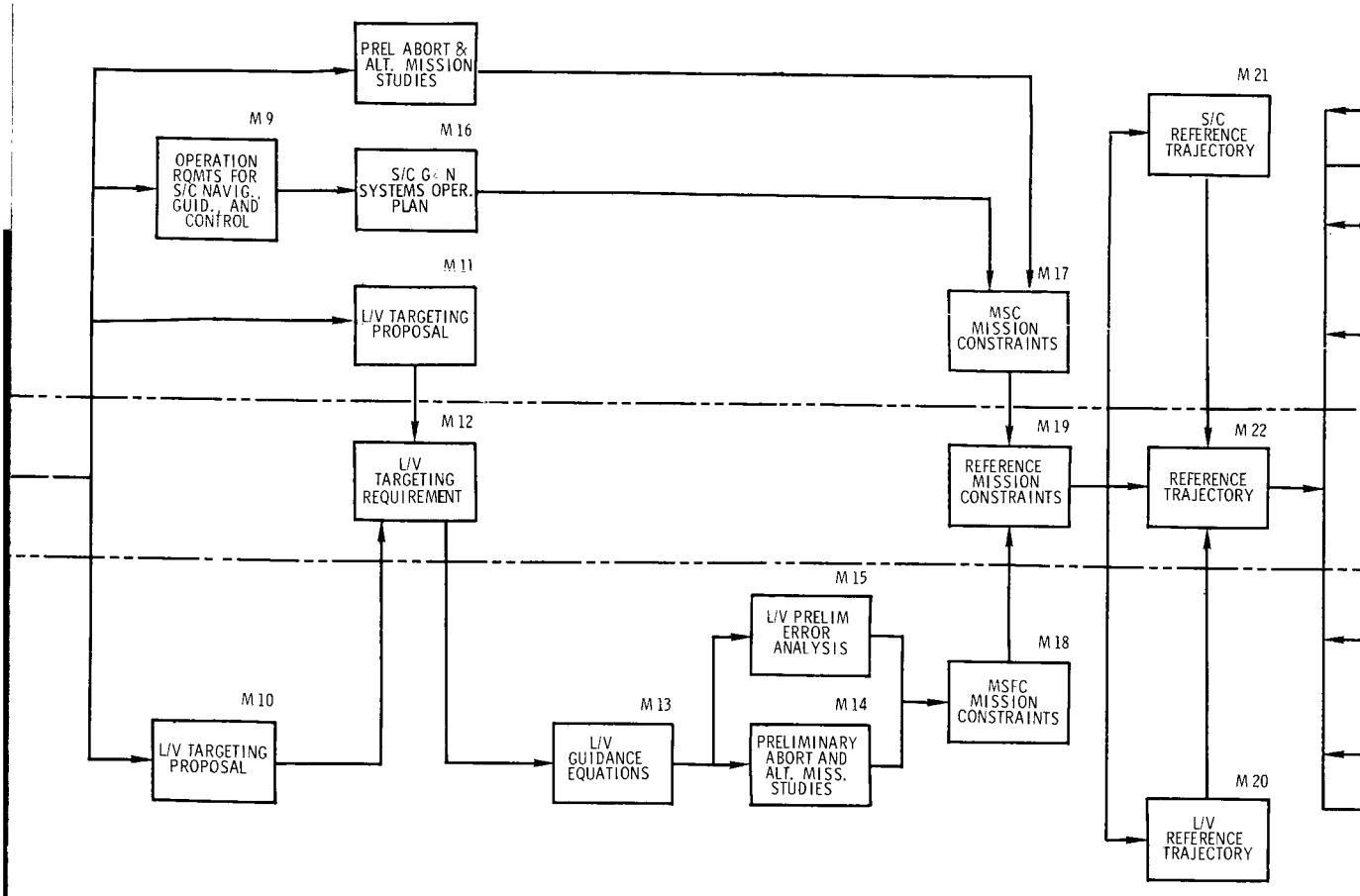


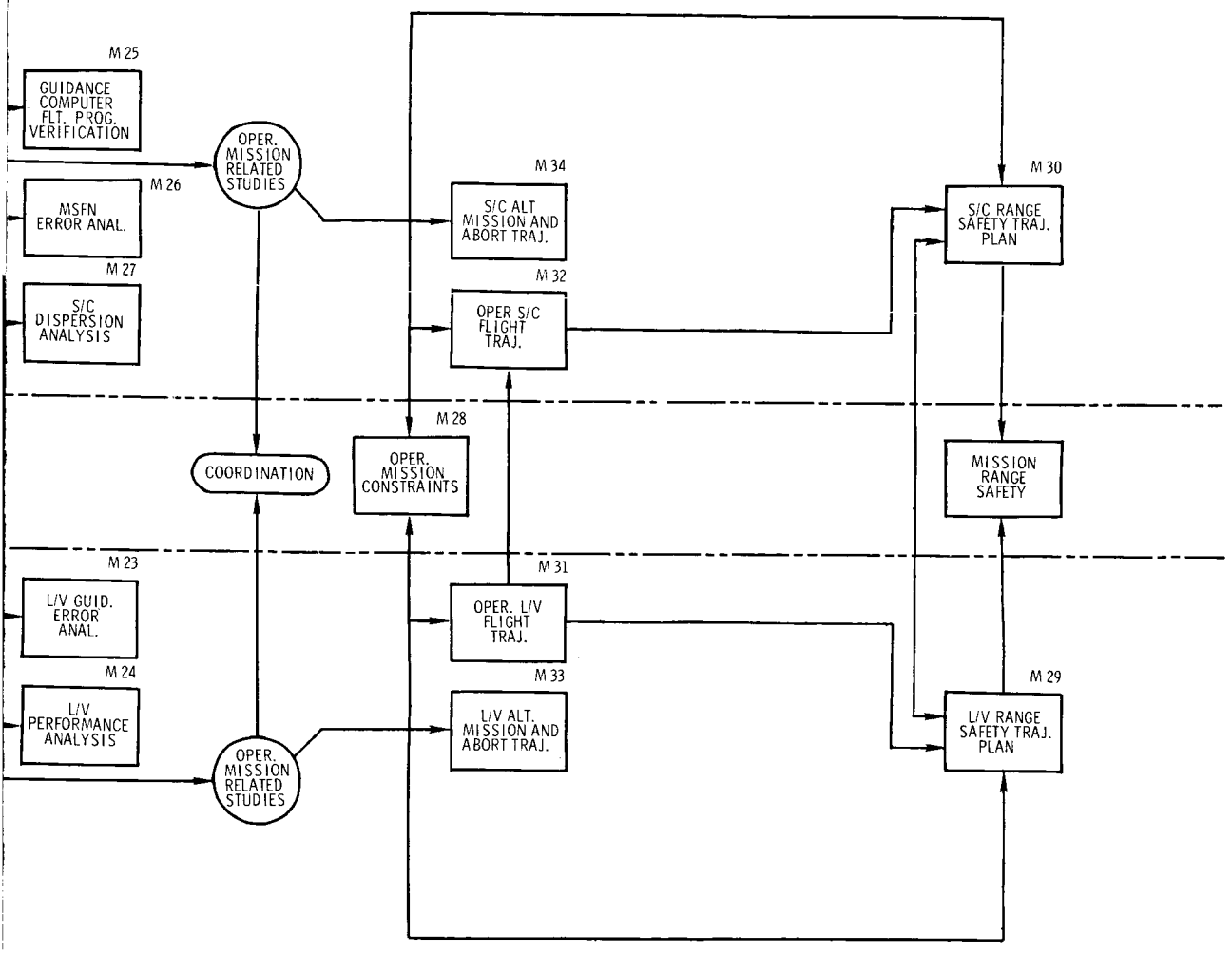
Figure 3. - Phase III - Flight preparation.


MSC
MSFC-MSC
MSFC
S/C MISSION REQUIREMENTS
L/V MISSION REQUIREMENTS
MISSION REQUIREMENTS CONSTRAINTS
M3
MSC PREL. MISSION PROFILE
M4
MSFC PREL MISSION PROFILE
M5
PRELIMINARY L/V REF. TRAJECTORY
M6
PRELIMINARY S/C REF. TRAJECTORY
M7
PRELIMINARY REFERENCE TRAJECTORY
M8



NOTE: SEE TABLE 1 FOR CORRELATION BETWEEN M NUMBERS AND MSC NUMBERS

Figure 4. - MSC-MSFC interface documentation flow plan.


M 25
GUIDANCE COMPUTER FLT. PROG. VERIFICATION
OPER. MISSION RELATED STUDIES
M 34
S/C ALT MISSION AND ABORT TRAJ.
M 30
S/C RANGE SAFETY TRAJ. PLAN
M 26
MSFN ERROR ANAL.
M 27
S/C DISPERSION ANALYSIS
M 32
OPER S/C FLIGHT TRAJ.
M 28
OPER. MISSION CONSTRAINTS
COORDINATION
MISSION RANGE SAFETY
M 23
L/V GUID. ERROR ANAL.
M 31
OPER. L/V FLIGHT TRAJ.
M 24
L/V PERFORMANCE ANALYSIS
M 33
L/V ALT. MISSION AND ABORT TRAJ.
M 29
L/V RANGE SAFETY TRAJ. PLAN
OPER. MISSION RELATED STUDIES

1. Test Requirements

Responsibility:	NAA/GAEC
Inputs From:	NAA/GAEC Systems and Subsystems Managers, MSC
Input To:	Mission Requirements and Constraints
Purpose:	These documents are expected to contain the CSM and LEM test requirements.
Typical Contents:	The exact content must be arranged between ASPO, NAA and GAEC.

Note: The "Test Requirements" may not be a document in itself but a part of a more general document. It is listed here only to indicate the contractor input to the ASPO Mission Requirements and Constraints document.

2. Spacecraft Mission Requirements

Responsibility: MSC/ASPO

Inputs From: Mission Assignment and contractors

Input To: Mission Requirements and Constraints

Purpose: This document contains the spacecraft objectives and requirements for the mission.

Typical Contents:
A. Objectives
   1. Spacecraft
   2. Operational
   3. Experimental
B. Test Requirements
C. System Characteristics
D. Standards

Note: This may not be an actual document, but is listed here to indicate that the information will be formulated by ASPO as an input to the joint Mission Requirements and Constraints document.

3. Launch Vehicle Mission Requirements

Responsibility: MSFC

Inputs From: Mission Assignment (NASA Headquarters)
Apollo Test Requirements (NASA Headquarters)

Input To: Mission Requirements and Constraints (MSC/MSFC)

Purpose: This document contains the launch vehicle objectives and requirements for the mission.

Typical Contents:
A. Objectives
   1. Launch Vehicle
   2. Operations
B. Test Requirements
C. System Characteristics
D. Standards

Note: This may not be an actual document but is listed to indicate the MSFC contribution to the Mission Requirements and Constraints which will be formulated at working group meetings under the auspices of the ASPO Systems Engineering Division.

4. Mission Requirements and constraints

Responsibility: ASPO

Inputs From: MSC, MSFC and constractors through the ASPO Systems Engineering Division's working group meetings.

Input To: MSC Preliminary Mission Profile
MSFC Preliminary Mission Profile

Purpose: This document contains the joint spacecraft and launch vehicle requirements altered by mutual agreement as is necessary for compatibility, and is used to guide the preliminary mission trajectory design.

Typical Contents:
A. Objectives
   1. Spacecraft
   2. Launch Vehicle
   3. Operations
   4. Experimental
B. Test Requirements (Detailed)
C. Systems Characteristics
D. Standards
E. Preliminary Mission Constraints

Note: This document will not be an ICD or receive wide distribution but will be incorporated in the appropriate Flight Mechanics Panel (FMP) ICD.

5. Apollo Mission Data Specifications A

Responsibility: MSC/ASPO (SED)

Input From: Subsystems Managers, ASPO, Contractors, MSFC, et al

Input To: Preliminary Mission Profile

Purpose: A single authoratative source for configuration and performance data to support trajectory calculations for mission planning and operational support. This initial issue of the data book will support the preparation of the Preliminary Mission Profile. Subsequent revisions will support the Preliminary Reference Trajectory, Reference Trajectory, and Operational Flight Trajectory, respectively. The level of detail of the data book increases with each revision.

Typical Contents:

A. Spacecraft
   1. Launch escape system
      a. Events and weights
      b. Propulsion systems performance
      c. Aerodynamics of stages
      d. Mass characteristics
   2. Command Service Module
      a. Events and weights
      b. Propulsion systems performance
      c. Maneuvering rates and accelerations
      d. Aerodynamics for impact and lifetime calculations
      e. Mass characteristics
   3. Command Module
      a. Events and Weights
      b. RCS performance
      c. SCS performance
      d. Entry corridor definition
      e. Entry heating equations and constants
      f. Mass characteristics
      g. Aerodynamics
   4. Lunar Excursion Module
      a. Events and weights
      b. Propulsion systems performance
      c. SCS
      d. Orbital drag aerodynamics
      e. Mass characteristics
      f. Impulse imparted by LEM staging

6. Performance Scan (Lunar Missions)

Responsibility: MPAD/MAB

Inputs From: Mission Requirements and Constraints
Apollo Mission Data Specification (ASPO)

Input To: Preliminary Mission Profile (MPAD)
Feedback to Mission Requirements and Constraints (ATSO)

Purpose: This document contains quantitative and qualitative information on mission objectives, requirements and constraints covering a three-month period covering the intended launch date. This information will permit mission analysis and selection of an optimum reference trajectory or set of trajectories. A secondary objective is to standardize the procedure and documentation for future performance scans on other flights.

Typical Contents:

(a) The 100% accessible lunar landing area for the three months selected.

(b) Selenographic latitude-longitude lines with best SM propellant reserves. The selenographic latitude-longitude lines are those limited by 15° and 45° sun elevation and 45° East and 45° West selenographic longitude. The trajectory configurations are as follows:

1. 90° launch azimuth
2. Translunar injections from both the Pacific and Atlantic Oceans
3. Translunar injection from one earth orbit later

(c) Daily lunar landing accessible area as constrained by lunar landing area arrival time and sun elevation at time of touchdown.

(d) Overlays showing daily lunar landing area accessible from both Pacific and Atlantic translunar injections.

6. Performance Scan (Lunar Mission) (Cont'd)

(e) SM and LEM performance characteristics for the desirable or candidate lunar landing sites.

1. SM propellant reserves for each of the daily earth launch window for 72° to 108° launch azimuths constrained as follows:

a) Translunar injection from both oceans (if accessible from both as shown by d).

b) First and second translunar injection opportunities.

c) Lunar stay time.

d) LEM out-of-plane capability.

e) Translunar and transearth flight time.

f) Earth return landing area.

(f) Aircraft Coverage Tracking and Communication data immediately before, during, and after translunar injection for launch azimuths between 72° and 108° for each trajectory configuration.

7. MSFC Preliminary Mission Profile

Responsibility: MSFC

Inputs From: Mission Requirements and Constraints

Input To: This document is the preliminary description of the L/V mission trajectory, and is intended merely to present its basic details for initial concurrence.

Typical Contents:

A. Mission Description
B. Weight and Mass Characteristics Data
C. Propulsion Subsystems Performance Data
D. Trajectory Data (Typical)
E. Sequence of Events
F. Tracking Data

8. MSC Preliminary Mission Profile

Responsibility: MSC/MPAD-FAB, MAB

Inputs From: Mission Requirements and Constraints and Apollo Mission Data Specifications A

Input To: Preliminary L/V and S/C Reference Trajectories Apollo Mission Data Specifications B

Purpose: This document is the preliminary description of the mission trajectory, and is intended merely to present its basic details for initial concurrence.

Typical Contents: (Development Mission)

A. Mission Description
B. Weight and Aerodynamics Characteristics
C. Propulsion Subsystems Performance
D. Trajectory Data (Typical)
E. Sequence of Events
F. Tracking Data

Typical Contents: (Lunar Mission)

A. Mission Description - verbal description of the characteristics of each phase of the mission

General - mission duration, landing sites, recovery area, lunar lighting conditions.

Launch - launch windows azimuth range

Earth Orbit - orbital elements
- insertion positions
- coast time to injection

TLI - position of initiate and terminate
- time of initiate and terminate
- injection energy required and payload capability

Transposition and docking - position and time when this should occur
- lighting conditions
- tracking available

8. MSC Preliminary Mission Profile (Cont'd)

T.L. trajectory - free return or not?
- flight time to perilune
- perilune conditions (position and velocity)

L.O.I. - time and position of maneuver initiate relative to perilune
- duration
- state vector at end of maneuver

B. Configuration data* - weights
- aerodynamics
- S/C propellant required
- thrust levels
- Isp's

C. Trajectory data - position and velocity time histories in coordinate systems appropriate for each phase
- geographic and selenographic tracks

D. Tracking data - times when tracking is not available
- List the stations that first acquire after TLI
- Time when 3 sites acquire after TLI

* Should be brief and reference Apollo Mission Data Specifications

9. Apollo Mission Data Specification B

Responsibility: MSC/ASPO (SED)

Inputs From: Subsystem Managers, ASPO, Contractors, MSFC, Preliminary Mission Profile, et al.

Input To: Preliminary Reference Trajectory

Purpose: This is the revision of the previous issue of the Data Book (number 5). The purpose is to update the data to support the generation of the Preliminary Reference Trajectory. Three sigma dispersion data will be included where applicable.

Typical Contents:

A. Spacecraft
   1. Launch escape System
      a. Events and weights
      b. Propulsion systems performance
      c. Aerodynamics of stages
      d. Mass characteristics
   2. Command Service Module
      a. Events and weights
      b. Propulsion systems performance
      c. Maneuvering rates and accelerations
      d. Aerodynamics for impact and lifetime calculations
      e. Mass characteristics
   3. Command Module
      a. Events and weights
      b. RCS performance
      c. SCS performance
      d. Entry corridor definition
      e. Entry heating equations and constants
      f. Mass characteristics
      g. Aerodynamics
   4. Lunar Excursion Module
      a. Events and weights
      b. Propulsion systems performance
      c. SCS
      d. Orbital drag aerodynamics
      e. Mass characteristics
      f. Impulse imparted by LEM staging

10. Preliminary L/V Reference Trajectory

Responsibility: MSFC

Inputs From: Preliminary Mission Profile

Input To: Preliminary S/C reference Trajectory and Preliminary Reference Trajectory

Purpose: This document contains a nominal launch trajectory that satisfies mission launch objectives and requirements taking into account MSFC constraints and L/V and S/C capabilities using preliminary estimates of L/V and S/C performance and characteristics.

Typical Contents:

A. Boost Phase Description
B. Weight and Mass Characteristics
C. Propulsion Subsystems Performance
D. Trajectory Data
E. Sequence of Events
F. Tracking Data

11. Preliminary S/C Reference Trajectory (Development Mission)

Responsibility: MPAD/FAB, MAB

Inputs From: Preliminary Mission Profile
Preliminary L/V Trajectory
Apollo Mission Data Specification B

Inputs To: Preliminary Reference Trajectory

Purpose: This document contains a nominal trajectory that satisfies mission objectives and requirements taking into account constraints and L/V and S/C capabilities using preliminary estimates of L/V and S/C performance and characteristics.

Typical Contents:
A. Mission Objectives and Requirements
B. Weight and Aerodynamic Characteristics
C. Propulsion Subsystem Performance
D. Trajectory Data
E. Sequence of Events
F. Tracking Data (Includes S/C look angles θ&ϕ and Doppler profiles)

Preliminary S/C Reference Trajectory (Lunar Mission)

Responsibility: MPAD/MAB

Inputs From: Preliminary Mission Profile
Preliminary L/V Trajectory and Data Book Revision 1

Input To: Preliminary Reference Trajectory

Purpose: This document contains an Apollo post-injection trajectory (after TLI but before Transposition and Docking) which satisfies all mission objectives and requirements, taking into account all operational constraints, S/C performance capabilities, and steering laws. These trajectories will use the nominal L/V ascent trajectory characteristics and earth relative coordinates at TLI as initial conditions. A family of trajectories will be presented for the following azimuths and constraints:

1. Launch Azimuths - 72°, 90°, 108°
2. One opportunity per day
3. Injection performed on second and third orbits

11. Preliminary S/C Reference Trajectory (Lunar Mission) (Cont'd)

Typical Contents:

A. Mission Objectives
   1. Test and experimental objectives

B. Mission Requirements
   1. Daily earth launch window for each of the lunar landing sites such that a minimum of three consecutive days is available for translunar injections for one ocean.
   2. Twenty-six degree launch azimuth range for each day of the daily earth launch window.

C. Tracking and Communication Data
   1. The following data for all S/C phases: Stations acquisition and blackout schedules - range
      - range rate
      - elevation
   2. S/C look angles (θ & ϕ) and doppler profiles during station passes.

D. S/C Trajectory Data
   1. Service Module - transpostion and docking data
      - pericynthion altitude
      - lunar orbit orientation
      - lunar orbit insertion trajectory parameters
      - transearth injection trajectory parameters

12. Preliminary Reference Trajectory (Development Missions)

Responsibility: MPAD/FAB, MAB - MSFC (thru Flight Mechanics Panel)

Inputs From: Preliminary L/V Reference Trajectory
Preliminary S/C Reference Trajectory

Input To: Launch Vehicle Targeting Proposals (MSFC-MSC), et al

Purpose: This document demonstrates an agreement between the two Centers that the Preliminary L/V and S/C Reference Trajectories are compatible and that the combination represents an acceptable Preliminary Reference Trajectory for each Center.

Typical Contents: This document will be in the form of a memorandum (or a short, more formal document) which briefly summarizes and references the individual MSC and MSFC Preliminary Reference Trajectories. The summary will be prepared in such a manner that the information required for the FMP ICD's will be easily extractable using the same tables and figures. The document will bear the signatures of the Co-Chairmen of the Guidance and Performance Subpanel, the Co-Chairman of the Flight Mechanics Panel (if required) and technical approval signatures as required by each Center.

Preliminary Reference Trajectory (Lunar Missions)

Responsibility: MPAD/MAB and MSFC (thru Flight Mechanics Panel with joint signature page)

Inputs From: Preliminary L/V Trajectory,
Preliminary Mission Profile,
Preliminary S/C Reference Trajectory

Input To: Launch Vehicle Targeting Requirements (MSC), et al

12. Preliminary Reference Trajectory (Lunar Missions) (Cont'd)

Purpose: This document contains a family of six nominal trajectories, all of them satisfying mission objectives and requirements, taking into account constraints and L/V and S/C capabilities using preliminary estimates of L/V and S/C performance and characteristics. This document combines the S/C and L/V preliminary reference trajectories in one continuous trajectory for each of the following azimuths and constraints:

1. Launch azimuths - 70°, 90°, 108°
2. One opportunity per day
3. Injection performed on second and third orbits

Typical Contents:

A. Mission Objectives and Requirements
B. Weight and Aerodynamic Characteristics
C. Propulsion Subsystem Performance
D. Trajectory Data
E. Sequence of Events
F. Tracking Data
G. Window
   1. Lighting
   2. Eclipse
   3. Radiation

13. Operational Requirements for Spacecraft Navigation, Guidance and Control

Responsibility: MPAD/FCD

Inputs From: Preliminary Reference Trajectory

Inputs To: Preliminary MSFN Error Analysis
S/C G&N Systems Operation Plan

Purpose: The purpose of this document is to specify the mission oriented spacecraft guidance requirements. It is intended that the information contained herein will be used in the final determination of the spacecraft guidance configuration, steering laws, guidance and control interface requirements, contingency plans, and spacecraft display data.

Typical Contents:

A. Requirements for Spacecraft Guidance and Navigation
   1. Apollo Guidance Computer Capability Requirements
      a. AGC Capability Requirements
      b. Update
      c. Maneuver Vector
      d. Control of Orbital Elements
      e. Thrusting Attitude
      f. Deorbit
      g. Reentry Guidance
   2. Digital Command System and Telemetry Implementation Requirements
   3. Spacecraft Display Requirements
B. Nominal Targets
C. Nominal and Contingency Operational Mission Plans
D. Real Time Computer Complex Interface Requirements
E. Review of Established Steering Laws
F. Reentry Guidance Logic

* This information will be combined with associated requirements generated within the Guidance and Control Division and will form the basis of a program specification (in combination with the Preliminary Reference Trajectory) from which MIT will begin flight program development for each mission.

14. L/V Targeting Proposal

Responsibility: MSC/MPAD-G&PB

Inputs From: Preliminary Reference Trajectory

Input To: L/V Targeting Requirements

Purpose: This document is used to give MSFC the L/V targeting requirements in order that the guidance equations can be determined with concurrence from MSFC. Perfect guidance is assumed.

Typical Contents:

A. Sequence of Events
B. Targeting Data and Tolerances
   This document will present a pericynthion "box" for a specified lifetime and inclination (lunar mission)
C. Ground Control G&C Requirements
D. L/V Mission Logic Requirements
E. Constraints
   1. Transposition and Docking constraints (appropriate missions)
   2. Communications constraints

15. L/V Targeting Proposal

Responsibility: MSFC

Inputs From: Preliminary Reference Trajectory (MSC-MSFC)

Input To: L/V Targeting Requirements (MSFC-MSC)

Purpose: This document gives the MSFC L/V targeting proposal.

Typical Contents:

A. Sequence of Events
B. Targeting Data and Tolerances
   This document will present a pericynthion "box" for a specified lifetime and inclination (lunar missions)
C. Ground Control G&C Requirements
D. L/V Mission Logic
E. Constraints
   1. Transposition and Docking Constraints (appropriate mission)
   2. Communications Constraints

16. L/V Targeting Requirements

Responsibility: MSFC-MSC (thru Flight Mechanics Panel)

Inputs From: Preliminary Reference Trajectory (MSC-MSFC)
L/V Targeting Proposals

Input To: L/V Guidance Equations (MSFC)

Purpose: This is a joint document agreed upon by MSC and MSFC and is a union of the two L/V Targeting Proposal documents prepared by the Centers. The document itself will not be an ICD or receive wide distribution, but will be incorporated in the appropriate FMP ICD.

Typical Contents:

A. Sequence of Events
B. Targeting Data and Tolerances
   This document will present a pericynthion "box" for a specified lifetime and inclination (lunar mission)
C. Ground Control G&C Requirements
D. L/V Mission Logic
E. Constraints
   1. Transposition and Docking Constraints (appropriate mission)
   2. Communications Constraints

17. L/V Guidance Equations

Responsibility: MSFC

Input From: L/V Targeting Requirements and
Preliminary Reference Trajectory

Input To: L/V Preliminary Error Analysis (MSFC)
Preliminary Abort and Alternate Mission Studies

Purpose: This document defines and describes the basic equations of the launch vehicle guidance system.

Typical Contents:
A. Guidance System Description
B. Targeting Parameters
C. Guidance Equations and Sequencing

18. S/C Guidance and Navigation Systems Operations Plan

Responsibility: MSC/G&CD

Inputs From: Operational Requirements for S/C Navigation, Guidance and Control

Input To: S/C Reference Trajectory
Preliminary Dispersion Analysis
Preliminary MSFN Error Analysis

Purpose: This is an interpretation from the guidance system viewpoint of what the mission is to accomplish, the shape of the trajectories, and the associated requirements placed upon the S/C Primary Guidance Computers. Operational descriptions will be included for both automatic and manual modes. This document will be revised by the "S/C Guidance and Navigation Systems Operation", document number 39.

Typical Contents:

A. Astronaut/Navigator functional requirements
B. Computer program functional requirements
C. Navigator/AGC interface
D. Flight sequence of events and timelines
E. Logic flow diagrams
F. Uplink AGC data and commands
H. Guidance equations
I. G&N error analysis
J. Tables of guidance gains and spacecraft characteristics
K. Allocation of variable storage
L. List of G&N instrumentation
M. Tracking requirements for G&N postflight analysis
N. Description of G&N system configuration
O. Flight plan reference trajectory
P. Definition of G&N test objectives

19. Preliminary MSFN Error Analysis

Responsibility: MPAD/MPB

Inputs From: Operational Rqmts for S/C Navigation, G&C
Preliminary Reference Trajectory

Input to: MSC Mission Constraints
Preliminary Dispersion Analysis

Purpose: This document provides an assessment of the navigational capabilities of the MSFN relative to the preliminary reference trajectory, and can serve as a source document in preparing final mission plans and MSFN implementation and operations plans.

Typical Contents:

A. A brief summary of the mission profile.
B. A description of the MSFN as applicable to the mission being studied. This description will enumerate the stations considered, the type of equipment available at these stations, data rates available, etc.
C. A statement of the statistical model used for each station enumerated in B.
D. A statement of the a priori information used in each phase of the mission.
E. A summary outline of the analysis of the navigation capability.
F. Results of the analysis of the MSFN navigation capabilities in the form of graphs, tables, etc., relating position and velocity uncertainties to tracking intervals, data rates, etc.
G. Conclusions and recommendations which can have an impact on final mission planning, MSFC implementation plan and operational procedures.

20. R.F. Coverage Evaluation

Responsibility: MSC/ISD

Inputs From: Preliminary Reference Trajectory

Input To: MSC Mission Constraints

Purpose: This document evaluates the ability of the spacecraft and ground system electromagnetic transmission systems to function throughout the mission as defined by the Preliminary Reference Trajectory. It indicates any changes which must be made to obtain satisfactory communications.

Typical Contents:

A. Any S/C attitude requirements for communication and carrier acquisition.
B. Communication time limits for each ground station on each pass.
C. Circuit margins
D. Estimated signal margins
E. R.F. Coverage Analysis
F. Communications Systems Limitations

21. Apollo Mission Data Specifications

Responsibility: MSC/ASPO (SED)

Inputs From: Subsystems Manager, ASPO, Contractors, MSC, Preliminary Mission Profile, et al.

Input To: Reference Trajectory

Purpose: This revision will update the data book where applicable and expand the data to support the generation of the Reference Trajectory.

Typical Contents:

A. Spacecraft
   1. Launch escape system
      a. Events and weights
      b. Propulsion systems performance
      c. Aerodynamics of stages
      d. Mass characteristics
   2. Command Service Module
      a. Events and weights
      b. Propulsion systems performance
      c. Maneuvering rates and accelerations
      d. Aerodynamics for impact and lifetime calculations
      e. Mass characteristics
   3. Command Module
      a. Events and weights
      b. RCS performance
      c. SCS performance
      d. Entry corridor definition
      e. Entry heating equations and constants
      f. Mass characteristics
      g. Aerodynamics
   4. Lunar Excursion Module
      a. Events and weights
      b. Propulsion systems performance
      c. SCS
      d. Orbital drag aerodynamics
      e. Mass characteristics
      f. Impulse imparted by LEM staging

22. Vehicle Detailed Test Plan

Responsibility: Contractor

Inputs From:
Mission Requirements
Preliminary Mission Profile
Preliminary Reference Trajectory

Input To: ASPO (PS & PF)

Purpose: The Test Plan shall be prepared in response to the definition of the mission requirements. The Test Plan shall include but not be limited to a description of the test vehicle, sequencing of testing, special equipment required to satisfy objectives, spacecraft support requirements, and the time phasing for equipment preparations, delivery and testing.

Typical Contents:

A. Introduction
B. Flight Test Objectives
C. Test Objective Evaluation Criteria
D. Test Vehicle Configuration
E. Flight Constraints
F. Mission Rules Summary
G. Schedule
H. Vehicle Checkout Plan
I. Flight Plans
J. Postflight Operations
K. Apollo Data Requirements
L. Test Reports
M. Range and Pad Safety
N. GSE Requirements
O. General Requirements
P. References

23. Mission Directive

Responsibility: MSC/PS & PF

Inputs From:
Flight Module Vehicle Test Plans
Mission Operations Plans
Reference Trajectories
Mission Requirements
Recovery Plans
Mission Flight Plans
Apollo Measurement Requirements
Reporting Plan for Apollo Missions

Inputs To: Test Operations

Typical Contents: The purpose of the mission directive is to provide a single authoritative identification and control of the requirements, objectives, assignment of responsibilities, and specific details of implementation for individual flights. Each mission directive shall include as a minimum a summary of the following:

(1) Flight Mission Profile.
(2) Flight hardware configuration of the space vehicle major systems and subsystems.
(3) Operational plans.
(4) Prelaunch sequence and flight sequence instructions including recovery and emergency procedures.
(5) Instrumentation lists summary.
(6) Tracking, communications and all other ground support system requirements.

24. Preliminary Abort and Alternate Mission Studies

Responsibility: MPAD

Inputs From: Preliminary Reference Trajectory

Input To: S/C Reference Trajectory
MSC Mission Constraints

Purpose: This document presents the analysis of alternate missions around the preliminary reference trajectory and the results of a general abort analysis which are applicable to the mission. (This study may draw upon the abort studies of TRW (Tasks A-5 and A-7), AMPTF and MPAD.

Typical Contents:

A. Analysis of possible combinations of alternate trajectories, the operational difficulties which might occur and the ΔV penalties required to complete the alternate mission.
B. Outline resulting ground rules for selection of alternate missions in real time based on study results and relative desirability of specific alternate missions.
C. Provide trajectory data for "canned" alternate missions. This data would be similar in type and format to the trajectory data in the P. R. T.
D. The characteristics of abort performance along trajectories typical of the specified mission profile will be examined in detail. These details include:
    1. ΔV required for time critical, fuel critical, and landing site aborts.
    2. Effect of reentry velocity constraints on abort performance.
    3. Effect of dispersion on abort performance.
    4. Determination of areas where delay of abort is desirable.
    5. Determination of areas where abort is impossible.
    6. Determination of areas where the time of performing the abort is critical to abort success.
    7. Determination of what perameters are significant for monitoring purposes in real time in order to make abort decisions.
    8. Determination of circumstances which affect the choice of abort paths.
    9. Effect of dispersions associated with abort maneuver on performance.

25. Flight Operations Plan

Responsibility: FOD

Input From: MSC, MSFC and contractor organizations

Input To: MSC, MSFC and contractor organizations

Purpose: This document is intended to contain all information which is required for the planning and implementation of the operational aspects of the mission.

Typical Contents:

A. Mission Plan
   1. Mission Objectives
   2. Mission Description by Phase
B. Flight Control Functions
   1. Evaluation
      a. Trajectory (tracking and computing)
      b. Astronaut Status
      c. Systems Status
   2. Control
      a. MSCC, Sites and Communications Network
      b. Voice, Command
C. Space Vehicle Communications Systems (Voice, TLM, Tracking)
   1. Launch Vehicle - C_5
      - S^2IVB
   2. Spacecraft - CSM
      - LEM

   (Brief systems descriptions)
D. Ground Operational Support System
   1. MSCC
   2. Voice Tracking and Command Networks - Ground to Space
   3. Data Lines - Ground to Ground
   4. Recovery Footprint
   5. Computational Facilities
E. Flight Control Procedures
   1. Ground Rules
   2. Flight Control Procedures by Mission Phase
      a. Prelaunch Checkout
      b. Countdown
      c. Abbreviated Flight Plan (Mission Decision Logic)

26. Preliminary Dispersion Analysis

Responsibility: MSC/MPAD

Inputs From:
S/C Guidance Equations
Preliminary MSFN Error Analysis
Apollo Data Specification
S/C Guidance and Control Systems Characteristics

Input To:
MSC Mission Constraints
S/C Mission Systems Compatibility
S/C Reference Trajectory

Purpose: This document provides dispersion in the spacecraft trajectory due to deviations in thrust, aerodynamics, atmospheric density, initial conditions and to G&N introduced errors. The results will include a statistical assessment of propellant margins, of dispersions, verification of tolerable reentry conditions for dispersions, and verification of the operational flight plan with dispersions.

Typical Contents:
A. Expected initial conditions
B. S/C error sources
C. S/C trajectory dispersions
D. G&N trajectory dispersions
E. Combined trajectory dispersions
F. Propellant margins
G. Tracking acquisition verification
H. Verification of reentry conditions
I. Verification of nominal operational flight plan with nominal dispersions.
J. Abort capability from dispersed trajectories

27. MSC Mission Constraints

Responsibility: ASPO/MPAD

Inputs From: S/C G&N Systems Operations Specification
Preliminary Dispersion Analysis
Preliminary MSFN Error Analysis
Reference Mission Constraints

Input To: Reference Mission Constraints

Purpose: This document is the MSC input to the Reference Mission Constraints document.

Typical Contents:
A. Spacecraft Constraints
B. Operational Constraints
C. Experimental Constraints

28. L/V Preliminary Error Analysis (Closed Loop)

Responsibility: MSFC

Input From: L/V Guidance Equations (MSFC)

Input To: MSFC Mission Constraints

Purpose: This document provides data on the possible errors at the targeting points or at the cut-off conditions

Typical Contents:
A. Nominal Trajectory
B. Component Accuracies
C. Measurement Accuracies
D. Cut-off Accuracies
E. Adherence to Optimum

29. MSFC Mission Constraints

Responsibility:	MSFC
Inputs From:	Preliminary Reference Trajectory L/V Preliminary Error Analysis
Input To:	Reference Mission Constraints
Purpose:	This document is the MSFC input to the Reference Mission Constraints document.
Typical Contents:	A. Launch Vehicle Constraints B. Operational Constraints C. Experimental Constraints

30. Reference Mission Constraints

Responsibility: MSC/MSFC

Inputs From: MSC Mission Constraints
MSFC Mission Constraints

Inputs To: S/C Reference Trajectory
L/V Reference Trajectory

Purpose: This document contains the joint constraints of MSC and MSFC which affect mission and trajectory design and must be final and complete enough to use for the final reference trajectory and mission design.

Typical Contents:

A. Vehicle Constraints
   1. Spacecraft
   2. Launch Vehicle
B. Operational Constraints
   1. Spacecraft
   2. Launch Vehicle
C. Experimental Constraints
   1. Spacecraft
   2. Launch Vehicle

Note: This document is a combination of the mission constraints from each Center and is a revision or updating of the constraints contained in the Mission Requirements and Constraints document. It will be incorporated into the appropriate FMP ICD. It should be formulated by an ad hoc committee of the Flight Mechanics Panel.

31. S/C Mission Systems Compatibility

Responsibility:	NAA/GAEC
Input From:	Preliminary Dispersion Analysis Preliminary Reference Trajectory
Input To:	ASPO S/C Reference Trajectory
Purpose:	This document is the contractors' response to the preliminary reference trajectory. He will be expected to identify systems capabilities to be either adequate or inadequate to fulfill the mission requirements.
Typical Contents:	The exact content of this document is the responsibility of ASPO and the contractors.

32. L/V Reference Trajectory

Responsibility: MSFC

Inputs From: Reference Mission Constraints

Input To: Reference Trajectory
S/C Reference Trajectory

Purpose: This document provides the L/V nominal trajectory plan which satisfies the mission objectives taking into account all constraints and using expected L/V and S/C performance, physical characteristics and capabilities, and guidance.

Typical Contents:
A. Boost Phase Description
B. Weight and Aerodynamic Data
C. Propulsion Subsystem Characteristics
D. Trajectory Data (nominal)
E. Sequence of Events
F. Tracking and Communications

33. S/C Reference Trajectory

Responsibility: MPAD

Inputs From: Apollo Mission Data Spec. C, L/V Reference Trajectory, Reference Mission Constraints, Spacecraft Mission Systems Compatibility, R.F. Coverage Evaluation, et al

Input To: Reference Trajectory
Flight Preparation (Phase III)

Purpose: This document provides the nominal trajectory plan which satisfies the mission objectives, taking into account all possible constraints and using expected L/V and S/C performance, physical characteristics and capabilities, and guidance. The guidance should consist of the steering laws plus any significant transfer functions of the mechanization. This document will be the source for revisions to the Operational Requirements for S/C Navigation, Guidance and Control (13).

Typical Contents:

Volume I
A. Mission Description
B. L/V and S/C Weight and Mass Characteristics and Aerodynamic Data *
C. L/V and S/C Propulsion Subsystem Performance *
D. Trajectory and Mission Related Ground Rules and Constraints
E. Trajectory Data - summarized
F. Tracking and Communications

Volume II
Tabulated Trajectory Data - Computer printout

Volume III
A. Tracking Data
B. Communications Data

* A very brief section which references the appropriate source document.

34. Reference Trajectory

Responsibility:	MSC/MSFC (thru Flight Mechanics Panel)
Input From:	L/V Reference Trajectory S/C Reference Trajectory
Input To:	Flight Preparation (Phase III)
Purpose:	This is a joint document which summarizes and references the individual MSC and MSFC S/C and L/V Reference Trajectories. It will indicate that the combination of the two individual documents represents an acceptable Reference Trajectory for each Center. It will be prepared in such a manner that the information required for the FMP ICD's will be easily extractible using the same tables and figures.
Typical Contents:	A. Introduction 1. Purpose (of document) 2. Scope B. Mission Description C. Trajectory Computer Printout D. References (S/C and L/V Reference Trajectory)

Note: This document will bear the technical approval signatures as required by each Center plus the signatures of the Guidance and Performance Subpanel Chairmen and the Flight Mechanics Panel Chairmen.

35. L/V Preliminary Abort and Alternate Missions Studies

Responsibility:	MSFC
Input From:	L/V Guidance Equations Preliminary EDS Limit Settings Mission Constraints
Input To:	S/C and L/V Operational Alternate Mission and Abort Trajectories Alternate Mission and Abort Plan
Purpose:	This document is to contain preliminary L/V data and information for abort and alternate missions.
Typical Contents:	A. Trajectory studies for definition of alternate missions and abort.

36. Real Time Program Requirements (TR 165A)

Responsibility: MPAD/RTPDB

Input From: FCD/Preliminary Reference Trajectory
Preliminary Abort and Alternate Mission Studies

Input To: FOD

Purpose: The purpose of this document is to detail the real time program requirements for each Apollo mission.

Typical Contents:

A. Introduction and Summary
B. Trajectory Processing Requirements
C. Telemetry Processing Requirements
D. Command Processing Requirements
E. Mission Operational Readiness and Confidence Testing (ORACT Program Requirements)
F. Specific Mission Requirements
G. Ground Systems Simulation Computer (GSSC) Simulation Program and Requirements

37. Preliminary Operational Timeline

Responsibility: Contractor

Input From: MSC and contractor organizations
Preliminary Reference Trajectory

Input To: Apollo Operational Timeline

Purpose: This document provides the initial planning for the integration of the mission constraints, operational requirements and crew activities to accomplish the mission objectives. It also provides a base for the development of crew operational procedures.

Typical Contents:

A. Trajectory Characteristics
B. Gross summary of sequence of events, system tests, experiments, maneuvers, etc.
C. Mission geometry charts and graphs
D. Operational timeline (to the system operations level)
E. Decision interval (GO/NO-GO)
F. System duty cycles
G. Consumables history
H. Weight, Cg and moment of inertia history
I. Attitude history
J. Aborts
K. Alternate mission operational timelines.

38. Apollo Mission Data Specification D

Responsibility: MSC/ASPO (SED)

Inputs From: Subsystems Managers, ASPO, Contractors, MSFC, Reference Trajectory, et al.

Input To: S/C Dispersion Analysis, Operational Flight Trajectory

Purpose: This revision of the data book will support the generation of the Operational Flight Trajectory. The previous data book will be updated and expanded as required.

Typical Contents:

A. Spacecraft
   1. Launch escape system
      a. Events and weights
      b. Propulsion systems performance
      c. Aerodynamics of stages
      d. Mass characteristics
   2. Command Service Module
      a. Events and weights
      b. Propulsion systems performance
      c. Maneuvering rates and accelerations
      d. Aerodynamic for impact and lifetime calculations
      e. Mass characteristics
   3. Command Module
      a. Events and weights
      b. RCS performance
      c. SCS performance
      d. Entry corridor definition
      e. Entry heating equations and constants
      f. Mass characteristics
      g. Aerodynamics
   4. Lunar Excursion Module
      a. Events and weights
      b. Propulsion systems performance
      c. SCS
      d. Orbital drag aerodynamics
      e. Mass characteristics
      f. Impulse imparted by LEM staging

39. S/C Guidance and Navigation Systems Operation Plan (Revision 1)

Responsibility: G&CD/MIT

Input From: Reference Trajectory

Input To: Guidance Computer Flight Program Verification
Operational Guidance Computer Program Verification Requirements
MSFC Error Analysis
S/C Dispersion Analysis

Purpose: This is an interpretation from the guidance system viewpoint of what the mission is to accomplish, the shape of the trajectories, and the associated requirements placed upon the S/C primary guidance computers. The assumption in the development of this plan is that the details of the mission are defined at this time by the reference trajectory and only those mission changes which can be accommodated in the erasable memory portion of the computer can be tolerated from this time on. This document will be the revision to document number 18.

Typical Contents:

A. Astronaut/Navigator functional requirements
B. Computer program functional requirements
C. Navigator/AGC interface
D. Flight sequence of events and timelines
E. Logic flow diagrams
F. Uplink AGC data and commands
H. Guidance equations
I. G&N error analysis
J. Tables of guidance gains and spacecraft characteristics
K. Allocation of variable storage
L. List of G&N instrumentation
M. Tracking requirements for G&N postflight analysis
N. Description of G&N system configuration
O. Flight plan reference trajectory
P. Definition of G&N test objectives

40. S/C Operational Guidance Computer Program Verification Requirements

Responsibility: MPAD/GCD

Input From: Reference Trajectory

Input To: Guidance Comp. Flight Program Verification

Purpose: This document serves to transmit FOD requirements for verifying the guidance computer programing to G&CD.

Typical Contents:

A. Introduction and Clarification of Required Tests
B. Grouping of Test Cases
C. Summary of Run Requirements
D. Printout and Output Requirements
   1. Vehicle simulation results
   2. Guidance equation results
   3. Periodicity of printout
   4. Number of copies
E. Listing and Detailing Test Cases

41. L/V Guidance Error Analysis

Responsibility: MSFC

Inputs From: Reference Trajectory (MSC/MSFC)

Input To: MSFN Error Analysis and S/C Dispersion Analysis (MSC), et al

Purpose: This document provides data on the possible errors at the target points or at cut-off conditions. It is based on the latest trajectory plan contained in the Reference Trajectory.

Typical Contents:
A. Updated Component Accuracies
B. Measurement Accuracies
C. Cutoff Accuracies

42. L/V Performance Analysis

Responsibility: MSFC

Input From: Reference Trajectory
L/V Guidance Error Analysis

Input To: Operational L/V Flight Trajectory
Operational Mission Constraints, et al

Purpose: This document provides the L/V performance analysis based on the Reference Trajectory.

Typical Contents:
A. Performance Dispersions at significant points
B. Dispersions Trajectories
C. Propellant Margins
D. Comparison of Performance Capabilities and Requirements
E. Dispersion data throughout Powered Flight

43. Guidance Computer Flight Program Verification

Responsibility: G&CD/MIT

Input From: Reference Trajectory and S/C Oper. Guidance Computer Program Verification Requirements

Input To: Operational S/C Flight Trajectory
Operational Mission Constraints, et al

Purpose: This is a description of the guidance computer verification test. This document will be the basis for acceptance of the computer programs by MSC.

Typical Contents:
A. Guidance error analysis
b. RCS fuel
c. Guidance performance reserve fuel
d. Appendix containing program listing
e. Failure mode analysis
f. Abort mode analysis

44. MSFN Error Analysis

Responsibility: MPAD/MPB

Inputs From: Apollo Mission Data Spec. D, S/C G&N Systems Operation, Reference Trajectory

Input To: Operational Flight Trajectory Plan, et al

Purpose: This document provides an assessment of the navigational capabilities of the MSFN relative to the reference trajectory. Its purpose is to affirm the conclusion and recommendation of the preliminary error analysis and to ascertain that no unexpected navigational constraints have been introduced by the reference trajectory.

Typical Contents:

A. A brief summary of the mission profile.
B. A description of the MSFN as applicable to the mission being studied. This description will enumerate the stations considered, the type of equipment available at these stations, data rates available, etc.
C. A statement of the statistical model used for each station enumerated in B.
D. A statement of the a priori information used in each phase of the mission.
E. A summary outline of the analysis of the navigation capability.
F. Results of the analysis of the MSFN navigation capabilities in the form of graphs, tables, etc., relating position and velocity uncertainties to tracking intervals, data rates, etc.
Conclusions.

45. S/C Dispersion Analysis

Responsibility: MSC/MPAD/G&PB

Inputs From:
MSFC: L/V Guidance Error Analysis and L/V Performance Analysis
MSC: S/C G&N Systems Operation
Apollo Mission Data Spec. D

Input To: Operational S/C Flight Trajectory, et al

Purpose: This document updates and augments the Preliminary Dispersion Analysis. It provides the dispersions in the spacecraft trajectory due to deviations in thrust, aerodynamics, atmospheric density, initial conditions and errors introduced by the G&N. The results will include a statictical assessment of the propellant margins, tracking acquisition verification in the presence of dispersions, verification of tolerable reentry conditions for dispersions and verification of the nominal trajectory with dispersions.

Typical Contents:
A. Expected Initial Conditions
B. S/C Error Sources
C. S/C Trajectory Dispersions
D. G&N Trajectory Dispersions
E. Combined Trajectory Dispersions
F. Propellant Margins
G. Tracking Acquisition Verification
H. Verification of Reentry Conditions
I. Verification of nominal trajectory with dispersions.
J. Abort Capability from Dispersed Trajectories

46. Initial RTCC Operations Support Plan

Responsibility: MPAD/RTPDB

Input From:
Flight Control
Reference Trajectory
L/V Guidance Equations
L/V Performance Analysis

Input To: MSCC Operations, Programmer Working Book

Purpose: This document provides MSCC operational personnel with information describing predicted support capabilities of the RTCC operational computer program and computer area. This information is based upon RTCC support requirements originated by flight control elements utilizing the MSCC. This document also provides MSCC operational personnel with information describing RTCC testing and flight support planning.

Typical Contents:
A. Introduction
B. Purpose
C. Scope
D. Mission Description
E. Real-time Computer Complex Objectives
F. Test Schedules and RTCC Countdown
G. Flight Acceptance Testing Support Plan
H. Computer Controller Procedures
I. RTCC Control Complex Configuration
J. Operational Computer Program Requirements
K. Data Formats and Program Constants
L. Tables

47. Apollo Operational Time Line

Responsibility: Contractors

Input From: Preliminary Operational Time Line, Reference Trajectory

Input To: Preliminary Mission Flight Plan

Purpose: This document updates and completes the information contained in the Preliminary Operational Timeline document.

Typical Content:

A. Trajectory Characteristics
B. Gross summary of sequence of events, system tests, experiments, maneuvers, etc.
C. Mission geometry charts and graphs
D. Operational timeline (to the system operations level)
E. Decision interval (GO/NO-GO)
F. System duty cycles
G. Consumables history
H. Weight Cg and moment of inertia history
I. Attitude history
J. Aborts
K. Alternate mission operational timelines.

48. Preliminary Mission Flight Plan

Responsibility: MSC/FCSD

Input From: Apollo Operational Time Line

Input To: Mission Flight Plan

Purpose: This document will contain, in preliminary form, all available information that identifies and time references all crew activities for accomplishing the mission objectives.

Typical Contents:

A. Introduction
   1. Mission Trajectory Characteristics
   2. Mission Phase and Sequence Identification
   3. Summary of System Flight Tests and Inflight Experiments
   4. General Notes (Flight Plan Rules, Spacecraft Operational and Environmental Constraints, Navigational Data, etc.)
B. Detailed Flight Plan
C. Special Activities
D. Consummable History, ΔV Budget
E. Summary Flight Plan
F. Contingency Plans

49. Operational Mission Constraints

Responsibility: MSFC/ ASPO

Inputs From: L/V, S/C and MSFC Error Analysis and S/C Dispersion Analysis, et al

Input To:
Operational S/C Flight Trajectory
Operations L/V Flight Trajectory
S/C Alternate Mission and Abort Plan
L/V Alternate Mission and Abort Plan

Purpose: This is the revised Reference Mission Constraints document and is used as a guide in the final mission planning and trajectory design.

Typical Contents:

A. Hardware Constraints
   1. S/C
   2. L/V
B. Operational Constraints
   1. S/C
   2. L/V
   3. MSFN
C. Experimental Constraints
   1. S/C
   2. L/C

50. Operational L/V Flight Trajectory

Responsibility: MSFC

Inputs From: L/V Guidance Error Analysis
L/V Performance Analysis
Operational Mission Constraints

Input To: Operational S/C Flight Trajectory

Purpose: This is the final L/V trajectory plan and contains the latest L/V guidance and error analysis data, and best mission and trajectory data. (It will be updated as necessary.)

Typical Contents:
A. Trajectory and Mission Related Ground Rules and Constraints
B. Vehicle Configuration
C. Weight and Performance Data
D. Operational Description of Mission
E. Operational Sequence of Events
F. Trajectory Data
G. Operational Dispersion Data
H. Tracking and Communications Data
I. Abort Modes and Contingency Plans
J. Alternate Mission Capabilities

51. L/V Range Safety Trajectory Plan

Responsibility: MSFC

Input From: Reference Trajectory (Joint)

Input To: Mission Range Safety
S/C Range Safety Trajectory Plan (MSC)

Purpose: To satisfy range safety requirements

Typical Contents:

A. Expected effects of destruct action and drag coefficients for resulting pieces.
B. Destruct system reliability and limits.
C. Failure modes and their probability of occurrence for the S-I and S-IVB stages.
D. Change in total velocity vector orientation in the lateral direction.
E. Expected nominal impact point for each stage or re-entry body and associated drag coefficients.
F. Impact dispersion for various stages and components due to destruct action.
G. Tracking equipment on board which can be used for range safety purposes and the stage or section where each piece of equipment is located.
H. Maximum expected lateral deviation from the intended flight path.
I. Maximum expected trajectory deviations during launch phase.
J. Statistical analysis to determine the probability of impact and injury for cases which involve the overflight of inhabited areas.
K. A magnetic tape and printout will be prepared for KSC and MSC, including the following powered flight trajectories:
   (1) Standard
   (2) Maximum Performance
   (3) Minimum Performance
   (4) Maximum Expected Lateral Deviation

52. L/V Alternate Mission and Abort Trajectory

Responsibility: MSFC

Input From: Reference Trajectory (MSFC-MSC) and Preliminary Abort and Alternate Mission Studies

Input To: Mission Operations

Purpose: This document contains the envelope of trajectories which are to be followed in the event a "L/V configuration" alternate mission or abort is required at any point in the mission.

Typical Contents:
A. Definition of Alternate Mission Trajectory Logic for Each Mission Phase
B. Definition of Abort Trajectory Families for Each Mission Phase
C. Trajectory Decision Logic for Each Mission Phase

53. Operational S/C Flight Trajectory

Responsibility: MPAD

Input From: Operational Mission Constraints
S/C Dispersion Analysis
Guidance Computer Flight Program Verification
Operational L/V Flight Trajectory
Apollo Mission Data Specification D

Input To: Mission operations

Purpose: The primary purpose of this document is to present the final mission plan trajectory data. It summarizes and presents all trajectory work performed to establish the nominal or planned mission and includes data desired by all elements supporting the specific mission.

Typical Contents: This is a comprehensive document and will be divided into separate volumes. The contents of these volumes should be similar to the following:

Volume I

A. Vehicle Configuration *
B. Weight and Performance Data *
C. Trajectory and Mission Related Ground Rules and Constraints *
D. Operational Description of Mission
E. Operational Sequence of Events
F. Launch window mechanism
G. Supplementary data - S/C sunrise, and sunset, moonrise - moonset, experiment associated data, propellant management, flight controller display, etc.

Volume II

A. Trajectory Data - printout
B. Operational Dispersion Data

Volume III

A. Tracking data (plots and tabulations)
B. Communications data (plots and tabulations)

* Very brief section which references the appropriate source document.

54. S/C Range Safety Trajectory Plan

Responsibility: MSC

Input From: Reference Trajectory (Joint)
L/V Range Safety Trajectory Plan

Input To: Mission Range Safety

Purpose: To satisfy Range Safety requirements

Typical Contents:

A. Expected effects of destruct action and drag coefficients for resulting pieces.
B. Destruct system reliability and limits.
C. Failure modes and their probability of occurrence for the spacecraft.
D. Change in total velocity vector orientation in the lateral direction.
E. Expected nominal impact point for each re-entry body and associated drag coefficient.
F. Impact dispersion for various stages and components due to destruct action.
G. Tracking equipment on board which can be used for range safety purposes and the stage or section where each piece of equipment is located.
H. Maximum expected lateral deviation from the intended flight path.
I. Statistical analysis to determine the probability of impact and injury for cases which involve the overflight of inhabited areas.
J. A magnetic tape and printout will be prepared for KSC and MSFC, including the following powered flight trajectories:
   (1) Standard
   (2) Maximum Performance
   (3) Minimum Performance
   (4) Maximum Expected Lateral Deviation

55. S/C Alternate Mission and Abort Trajectory

Responsibility: MSC/MPAD

Inputs From: Preliminary Abort and Alternate Mission Studies, Guidance Comp. Flight Program Verification, MSFN Error Analysis, S/C Dispersion Analysis, et al

Input To: Operational requirement

Purpose: This document is an updating and augmentation of the Preliminary Abort and Alternate Mission Studies. It contains a quantitative presentation of flight control parameters, limit lines, etc., for alternate mission and abort decisions.

Typical Contents:

Alternate Mission

1. For each mission phase, define the limits on the appropriate trajectory parameters which require alteration to the mission.
2. List the alternatives.
3. Trajectory Decision Logic for each mission phase
4. All necessary plotted or tabulated data to substantitate the logic and satisfy the requirements.

Abort

1. For each mission phase, define the trajectory limitations which will cause an abort to be initiated.
2. Summarize the abort performance throughout the mission; e.g.: 1) minimum time to return to primary recovery area, or contingency areas vs. mission time; 2) minimum ΔV to return to safe reentry; 3) "way station" abort target data. Do 1) and 3) for each propulsion system available.
3. Trajectory control display data for each phase.
4. Trajectory decision logic for each mission phase.
5. All necessary plotted or tabulated data to substantiate the logic and satisfy the requirements.

56. Spacecraft Orbital Debris

Responsibility: MPAD (FAB)

Input From: S/C Contractors, Reference Trajectory

Output To: NASA Headquarters

Purpose: This document describes the probability of casualty resulting from spacecraft orbital debris. It includes analysis of hazards due to orbital decay, forcedreentry and earth return trajectories, both nominal and aborted. It excludes consideration of hazards resulting from entirely suborbital flight, which are included in the Range Safety Study.

Typical Contents:

a. Trajectory analysis for lifetime predictions and establishment of earth reentry conditions.
b. Aero, thermal, and structural analyses used to determine breakup mechanisms, breakup altitudes, and resulting pieces.
c. Survivability of debris.
d. For surviving debris, number of pieces, size, weight, lethal area, and impact dispersions.
e. Hazards due to surviving debris.
f. Possible means to reduce hazards.

57. Programmer Working Book

Responsibility: MSC/MPAD

Inputs From: Initial RTCC Operations Support Plan

Inputs To: Mission

Purpose: The purpose of this book is to define the development of the RTCC program systems. Its use will facilitate the coordination of the many individual efforts which comprise the total programming endeavor. All procedures and standards set forth herein are to be strictly observed and will be rigidly enforced, if necessary, to maintain efficient control of the many programming facets. Finally, this book will contain the write-ups for all of the RTCC programs, in order to provide a readily accessible system reference.

Typical Contents:

A. Introduction
B. Standards
C. Compiler/operating system
D. Executive
E. Mission
F. Analyzer
G. Operational readiness and confidence testing
H. Simulation
I. Utility
J. Functional specifications

58. S/C and L/V Guidance Compatibility Verification

Responsibility: MSC/MSFC

Inputs From: Operational Flight Trajectory

Inputs To: Mission

Purpose: This document will provide quantitative data or evidence that a switchover from booster guidance to S/C takeover will result in a satisfactory launch trajectory.

Typical Contents: Results of analyses and simulations of switchover. Specifically:

Attitude transients
Trajectory parameters
Fuel used

} Compared to non-takeover cases

Show dispersion limits from which recovery can be made by switchover.

Delineate critical portions of trajectory for switchover.

59. RTCC Operations Support Plan

Responsibility: MPAD/RTDPB

Input From: FCD, Initial RTCC Operations Support Plan

Input To: MSCC Operations

Purpose: This document is similar to the Initial RTCC Operations Support Plan except this document provides MSCC operational personnel with detailed definitions of the support capabilities of the RTCC operational computer program and computer control area. This plan serves as a control document, and is utilized as a handbook by personnel participating in RTCC mission operations support.

Typical Contents:

A. Introduction
B. Purpose
C. Scope
D. Mission Description
E. Real-time Computer Complex Objectives
F. Test Schedules and RTCC Countdown
G. Flight Acceptance Testing Support Plan
H. Computer Controller Procedures
I. RTCC Control Complex Configuration
J. Operational Computer Program Requirements
K. Data Formats and Program Constants
L. Tables

60. Mission Flight Plan

Responsibility: MSC-FCSD

Input From: MSC and contractor organizations

Input To: MSC Crew Training and Mission

Purpose: This document will identify and time reference all crew activities for accomplishing the mission objectives.

Contents:

A. Introduction
   1. Mission Trajectory Characteristics
   2. Mission Phase and Sequence Identification
   3. Summary of System Flight Tests and Inflight Experiments
   4. General Notes (Flight Plan Rules, Spacecraft Operational and Environmental Contraints, Navigational Data, etc.)
B. Detailed Flight Plan
C. Special Activities
D. Consummable History, ΔV Budget
E. Weight and Balance History
F. Summary Flight Plan
G. Contingency Plans

61. Postflight Trajectory Analysis

Responsibility: MPAD/FAB

Input From: Flight Data, Operations Mission Trajectory Plan (MPAD)

Input To: ASPO

Purpose: To evaluate and document the trajectory performance of the mission.

Typical Content:

A. Flight Trajectory
B. L/V Guidance and Performance
C. S/C Performance (G&N)
D. Network Performance
E. Summary of Dispersions
F. Critique of:
    1. Hardware Performance
    2. Software Performance
    3. Procedures
G. Sequence of Events

ORGANIZATIONAL ABBREVIATIONS

AMPTF	- Apollo Mission Planning Task Force
ASPO	- Apollo Spacecraft Program Office
SED	- Systems Engineering Division (PS)
FPD	- Flight Projects Division (PF)
FCD	- Flight Control Division
FCSD	- Flight Crew Support Division
FOD	- Flight Operations Directorate
FMP	- Flight Mechanics Panel
GAEC	- Grumman Aircraft Engineering Corporation
G&CD	- Guidance and Control Division
ISD	- Information Systems Division
NAA	- North American Aviation, Inc.
NASA	- National Aeronautics and Space Administration
MIT	- Massachusetts Institute of Technology
MPAD	- Mission Planning and Analysis Division
ATSO	- Apollo Trajectory Support Office
FAB	- Flight Analysis Branch
G&PB	- Guidance and Performance Branch
MAB	- Mission Analysis Branch
MPB	- Mathematical Physics Branch
RAB	- Rendezvous Analysis Branch
RTPDB	- Real Time Program Development Branch
MSC	- Manned Spacecraft Center
MSFC	- Marshall Space Flight Center
TRW	- Thompson Ramo Wooldridge, Inc.

MISSION PLANNING AND ANALYSIS DIVISION
APOLLO TRAJECTORY DOCUMENT DISTRIBUTION

Document	Distribution Code
Performance Scan	D
MSC Preliminary Mission Profile	A
Preliminary S/C Reference Trajectory	A
Preliminary S/C Reference Trajectory - Computer Printout (Volume II)	B
Preliminary S/C Reference Trajectory - Radar Data (Volume III)	G
Operational Requirements for S/C Navigation, Guidance and Control	C
L/V Targeting Proposal	
Preliminary MSFN Error Analysis	D
Preliminary Abort and Alternate Mission Studies	A
Preliminary Dispersion Analysis	D
S/C Reference Trajectory	A
S/C Reference Trajectory - Computer Printout (Volume II)	B
S/C Reference Trajectory - Radar Data (Volume III)	G
Real Time Program Requirements (TR165A)	Note 1
S/C Oper. Guidance Computer Program Verification Requirements	C
MSFN Error Analysis	D
S/C Dispersion Analysis	D
Initial RTCC Operations Support Plan	F
Operational S/C Flight Trajectory	E
S/C Range Safety Trajectory Plan	E
S/C Alternate Mission and Abort Trajectory	E
S/C Orbital Debris	E
L/V and S/C Guidance Compatibility Verification	C
RTCC Operations Support Plan	F
Postflight Trajectory Analysis	A

Note 1: The distribution plan for the volumes of this document may be found as an enclosure to Philco letter Z-514-A-65/L#82, dated June 24, 1965, to L. Dungan from J. Saxton, subject: "Distribution list, TR 120A and TR 165A."

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23	6	15	10	15	19	2	FC/J. D. Hodge
5		1	1	5	5		FL/R. G. Thompson
1	3	3	5	3	34	1	FM/J. P. Mayer
40	2	20	12	20		5	FM/J. P. Bryant

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5				5			NASA Headquarters, MO
8				15			KSC (Dr. A. H. Knoethe)
10	1	5	5	10		1	MSFC (Harold Ledford)
5		1	5	5		1	GSFC (Dr. F. O. Vonbun)
5		5	5	5		1	Bellcomm (Mr. R. Wagner)
20	5	2	20	2		2	NAA (Mr. W. L. Steinwachs)
1		1	1	1			RASPO, NAA (Thru FM)
15	2	2	15	2			GAEC (Mr. W. C. Schoen)
1		1	1	1			RASPO, GAEC (Thru FM)
5		5	5	5			TRW (Thru FM)
5	2	5	5	2		2	MIT (Mr. John Dahlen)(Thru FM)
					6		Philco (Houston)
1			1	1	32		IBM (Houston/Paul Tani)